DOCUMENT RESUME

ED 252 394 SE 045 313

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TITLE The Framework Revisited. Learning in Science Project (Primary). Working Paper No. 111.
INSTITUTION Waikato Univ., Hamilton (New Zealand). Science Education Research Unit
PUB DATE Feb 83
NOTE 26p.; For related document, see SE 045 303.
PUB TYPE Reports - Evaluative/Feasibility (142)

EDRS PRICE MF01/PC02 Plus Postage.
DESCRIPTORS Comprehension; Concept Formation; Concept Teaching; *Curriculum Development; Elementary Education; *Elementary School Science; Foreign Countries; Learning Strategies; *Research Design; Research Needs; Science Curriculum; Science Education; *Science Instruction; Science Projects; *Teaching Methods
IDENTIFIERS *Learning in Science Project (Primary); *New Zealand; Science Education Research

ABSTRACT

The first working paper of the Learning in Science Project (Primary)--LISP(P)--"Toward a Framework," outlined what was then seen (1982) as the major aim of the project and proposed a research plan that seemed capable of enabling the project to establish difficulties that teachers have teaching science, to identify difficulties children have learning science, and to explore ways of overcoming such difficulties. The plan included an exploratory phase, an in-depth phase, and a tentative action-research phase, with teachers involved in all project phases. Presented in this document is a reconsideration of the initial framework, reviewing the LISP(P) perspective on primary science, outlining a proposed primary science teaching model, and specifying steps in the formation of a research plan. The plan includes: (1) using the "interview-about-instances" (IAI) method to determine children's ideas about various science topics; (2) investigating children's questions and explanations on a topic using the proposed teaching model; (3) teachers executing the proposed teaching model (supported by information obtained from the IAI and from data on children's questions and explanations); and (4) development of teaching guides. A discussion of topics that should be the focus of LISP(P) research and (in an appendix) information for teacher-researchers who want to participate in the project are included. (JN)

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# LEARNING IN SCIENCE PROJECT (PRIMARY)

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# THE FRAMEWORK REVISITED

Science Education Research Unit
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SE045313

Working Paper No. 111

# THE FRAMEWORK REVISITED

Fred Biddulph, Roger Osborne, Peter Freyberg

February 1983

A Working Paper of the Learning in Science Project (Primary)

## INTRODUCTION

In the first Working Paper of the Learning in Science Project (Primary), Osborne (1982) suggested aspects of primary science that should be the focus of research and he proposed a research plan that seemed likely to enable the Project to establish the difficulties that teachers have teaching science, to identify the difficulties that children have learning science, and to explore ways of overcoming such difficulties. Briefly, he envisaged an exploratory phase in which the views of teachers would be sought and observations of children at work in classrooms would be made. This would be followed by an indepth phase in which children's ideas, explanations, thinking and practical skills would be investigated in detail, and in which children's attitudes to science and views about the technological world would also receive consideration. Finally, he suggested that an action-research phase may be required but the nature of such a phase was not immediately clear. It was emphasized in this first paper that if the research was to have relevance to teachers then they should be involved in the research from an early stage.

The suggested framework provided was used as a guide to research, especially in the initial exploratory phase. Almost one hundred inspectors, teachers college science staff, science advisers, principals, teachers and children were interviewed and their views about the difficulties of teaching and learning science at the primary level were reported (Biddulph, 1982a). Observations of a range of science lessons in primary classrooms were also made and these too were reported (Biddulph, 1982b). Some unanticipated difficulties, however, were encountered and the resolution of these pointed to the need for a reconsideration of the framework.

## PERSPECTIVE ON PRIMARY SCIENCE

It became apparent during the exploratory phase that what was meant by 'science' at the primary level was not entirely clear as even science educators held diverse views on the matter. This caused difficulty since it was necessary for Project members to know what it was they were to focus on before research could continue. Accordingly, after considerable deliberation, a particular perspective was adopted (Symington, Osborne, Freyberg and White, 1982). Briefly, this is that

primary science should encourage and enable children to ask questions, to do things and to think about things in a way that will help them make better sense of their world. With respect to the reason that certain phenomena behave as they do, primary science should also help children to appreciate explanations different from their own and to appreciate in what ways some of these explanations may be more useful than their own current explanations.

This possible perspective on primary science was reflected off teachers, science advisers, international experts on primary science and curriculum developers. The reaction of these people to this perspective suggested that it could be a useful Project perspective.

Having established the perspective, the Project next considered the implications for further research into the problems of primary science, and the type of support that teachers might need to reorient their science teaching to the above perspective. Such a reorientation would need to fully consider teachers' lack of confidence in teaching science and our observation that many teachers interpreted their role as primarily one of giving children science knowledge.

## TEACHING PROCEDURES FOR GATHERING INFORMATION ABOUT CHILDREN'S VIEWS OF THE WORLD

If science teaching is to be consistent with the perspective of primary science outlined above then it seems that children's questions and explanations should have a central place in that teaching. If information about children's questions and explanations with respect to specific topics were to be available then this would enable teachers to anticipate class reactions and in this way would provide teachers with an increased measure of confidence. Following some exploratory work in classrooms by Project members, procedures by which the Project team could obtain such information were spelled out (Symington, Osborne, Biddulph and Freyberg, 1982). It was proposed that children's questions and answers be obtained in full class studies, in small group situations and in individual interviews.

It was then realised that the procedures, as well as serving as a research procedure, could form the basis of an alternative teaching approach (Biddulph & Osborne, 1982) (see Table 1 below) that had the potential of guiding teachers towards the perspective mentioned previously. It was also realised that the distinction between the indepth and action-research phases of the Project made in the first paper of the Primary Project (Osborne, 1982) was a distinction that was unlikely to be helpful if, as seemed desirable, teachers were to be as fully involved as possible in the research work.

Table 1: PROPOSED PRIMARY SCIENCE TEACHING MODEL

Step 1: CHILDREN IN INTERESTING SITUATION
A situation that stimulates the children to ask questions related to a science topic.

Step 2: CHILDREN'S QUESTIONS ON THE TOPIC
These could be publicly recorded eg. on the board

Step 3: CHILDREN'S SUGGESTED ANSWERS TO A QUESTION
These could be written on paper by the children either individually or in groups and if desired then also listed on the board.

Step 4: CHILDREN'S RESEARCH PROPOSALS
At this step the children either individually or in groups write a research proposal outlining:
(a) the question/answer they are going to check on
(b) how they are going to check on it
(c) where they are going to check on it
(d) how long they estimate they will take
(e) what equipment they will need
Teacher approval will be necessary before children embark on Step 5. (A teacher may decide to accept some proposals that are doomed to failure but from which children will learn something useful.)

Step 5: CHILDREN'S RESEARCH ACTIVITY
The children conduct an inquiry on their problem using their suggested activity. This may be
(a) observation or 'experiment'
(b) consulting books
(c) consulting knowledgeable people

Step 6: CHILDREN'S RESEARCH REPORT AND PEER COMMENTS
The children report their findings to the rest of the class. The other children, with teacher guidance, comment on
(a) whether or not the group or individual had really found out what they were trying to find out.
(b) possible alternative explanations
(c) other studies that might follow

NOTE: The model is explained more fully in the Appendix.

## A REVISED FRAMEWORK

We begin by setting forth a research plan. The plan seems to us to encompass a framework to guide individual research activity for much of the remainder of the Primary Project. The framework could be used by full-time or part-time researchers to gather data on both children's thinking and the alternative teaching approach in the context of a concept, topic, theme or situation. A set of such studies done by a range of researchers would individually provide specific information for teachers on a range of topics, and collectively provide some more general information for future curriculum development. The plan which we will now describe in detail is set out schematically in Figure 1.

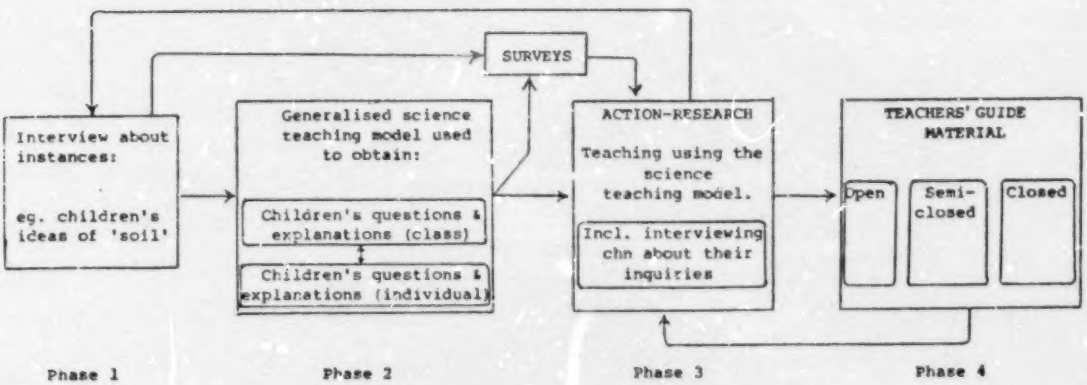


Figure 1: Primary science research plan 1983-84

The interview-about-instances is included as the first phase of the plan because it seems advisable to find out the ideas that children have about topics, before we proceed further with research on that topic. If it seems desirable then the prevalence with which children of a particular age, or children across an age range, hold certain ideas could be investigated using surveys constructed from the information gained in the initial interviews. It is also quite likely that in the course of the action-research where children are working in small groups advancing explanations, formulating research proposals, executing them and constructing reports of their investigations they will use some words, or offer some notion, whose meaning one would want to explore further with them by way of individual interview; hence the arrow on the plan from the action-research step back to the interview-about-instances step.

Having established what the children's ideas are with respect to a topic, the next phase in the research plan would require that children's questions and explanations with reference to that topic be obtained using a generalised form of the alternative teaching approach. In effect this would mean placing the children in a stimulus situation that is likely to result in them generating questions on the topic, recording the questions that they ask in their class group at the end of the stimulus period, and obtaining their suggested answers or explanations to one or more of the questions. This aspect of the step could be performed by either the class teacher in a research role or by another researcher eg. school principal, science adviser, Project member. It is likely to be desirable to establish the commonality of questions, and possibly explanations, at various class levels, in which case the above step could be repeated in a number of classes for the same topic. In this case it could be thought of as a type of survey. Other types of information that could be obtained in this second phase are: whether or not different stimulus situations result in children asking quite different questions on the same topic; of the various questions asked, which the children consider the most interesting; of the explanations offered, which the children consider most sensible. Class teachers may be able to gather some data on these but it will also be necessary to interview children individually about questions

and answers to find out why they prefer some to others. If a researcher works in co-operation with a teacher then it would also be possible for the kind of data resulting from phase 2 to be obtained from phase 3 as the teacher uses the alternative teaching approach to take a series of lessons on a topic. In this case the researcher would simply interview children before the first lesson and between some of the succeeding lessons.

The third phase, or action-research phase, would require the class teacher to execute the alternative teaching approach but with the knowledge that the children have certain ideas and, as time goes by and data are collected, with the knowledge that children tend to ask certain questions and offer certain explanations on a topic. During this phase the researcher would be interested in monitoring difficulties that the teacher might encounter, and would be observing the investigatory, communicative and thinking skills together with the ideas that the children use. Informal interviews with the teacher, unobtrusive informal discussions with the children, and discussions among the children as they work would be audio-taped during this phase. Interviews with individual or small groups of children would be necessary to probe why they engaged in certain lines of inquiry and what they learned from their inquiries. This would be necessary because preliminary observations suggest that what children formally report in class situations doesn't necessarily reflect their thinking in small group discussions (Biddulph, 1982b; Biddulph and Roger, 1983).

The final phase of the research plan would require teachers' guide material to be written on the topics investigated in the earlier steps. Since teachers vary in their level of confidence and competence in science teaching it would seen desirable to think in terms of producing guide material to cater for variations in teacher confidence and ability. It is therefore envisaged that teachers who are reasonably confident and competent would find open-type material of sufficient guidance. Such material would outline the meanings that children have for a key word (or words) of a topic, the range and typicality of, and preference for, the questions that they ask and the explanations that they offer, and the teaching steps of the proposed

teaching approach. Those teachers who lack confidence and who welcome precise guidance could be provided with carefully structured or 'closed' material which set out in detail what a teacher could do and the ways in which the children would be likely to respond; for example, explicit instructions for introducing children to a stimulus situation could be given. There may be some teachers who would like a little more detail than that provided in the 'open' guide materials but not as much as that provided in the 'closed' materials; hence the suggested need for guide materials to be also written with an intermediate degree of structure, designated 'semi-closed' in the research plan. Finally, the plan would require that these guide materials be trialled by teachers in classrooms and that the trials be carefully monitored by researchers in a second action-research phase. The loop between action-research and guide materials indicates that guide materials could be revised and retrialled, several times if necessary.

The research plan is not entirely untried. The interview-about-instances aspect has already proven its value in the Form 1 to 4 Project and elsewhere. Further, two of the Project members and three teachers have found that it is feasible to obtain children's questions and explanations by following the initial steps of the proposed science teaching approach. One of the teachers, in fact, has used the alternative teaching approach in its entirety without being provided with any teacher resource materials (Biddulph and Roger, 1983). It is envisaged that the research plan would be used to gather data on a number of science topics. It should also be possible for teachers, principals or advisers to use parts of the research plan, especially phases 1 and 2, in a research capacity. To this end, Appendix 2 sets out for practising teachers information about the Project, the alternative teaching approach, and how they could be involved.

## WHICH TOPICS SHOULD BE THE FOCUS OF OUR RESEARCH?

In an earlier paper (Symington, Osborne, Fryberg & White, 1982) it was proposed that,

> "The topics chosen should be 'close to children'. By this we mean that the phenomena are part of the child's immediate world and that they are phenomena about which the child is interested, asks questions and can form real understandings (eg. the growth of plants). This entails more than choosing topics on the basis of what we think children will be interested in."
>
> (p.6)

We still regard this as a sound proposal and would add that the topics should also be manageable by teachers, they should be able to be taken with easily available resources, and they should not lead to later confusion in science learning. Our problem, however, is how to draw up an initial list of topics for investigation in this Project. We are interested in finding topics which meet these criteria but which are also suited to the teaching procedure outlined.

The Project does not really have the resources to investigate every available topic. The most it is likely to be able to achieve is the development of a few topics as illustrative examples. Consequently it is important to include in the research programme some topics that seem to meet the criteria and some that, on the surface, appear not to. Rather than guess which topics might be in each category, the views of teachers, children and science advisers were sought as a guide. Thirty primary teachers (J.1 - S.4) and 460 children (S.1 - S.4) were surveyed in June and September, 1982, respectively. This work showed the difficulties involved in accurately gauging pupils' interest or potential interest in a topic. For example, it was found that pupils' stated interests did not necessarily reflect their actual interests, except perhaps in the area of living things. An illustration of this was that few children at any level said that they were interested in 'metals' but later in the year, when this topic was introduced to five S.3/4 classes using an alternative teaching approach, the children showed considerable interest.

In November, 1982, science advisers were each invited to list 20 topics that they thought should be investigated by the Project team and to give their reasons for their choice of topics. Eleven advisers replied and collectively listed 106 topics or primary science units. An analysis of their replies indicated that their reasons for listing topics fell into six categories. Two of these related to the perceived

use that teachers made of the topics, two related to the perceived interest shown by the children in the topics, one related to the perceived level of difficulty of the ideas contained in the topics for the children, and the sixth category contained an assortment of reasons. Examples of topics in this last category (with reasons in parentheses) were: fibres (an unusual unit); wood (unit activities don't seem to be linked to objectives); roadside, native bush, waste area (too broad); spring, autumn (badly taken). Topics or units mentioned by the advisers relating to teacher use are shown in Table 2 below, those relating to children's interest are shown in Table 3, and those which the advisers considered may contain ideas that are too difficult for primary children at the levels specified are shown in Table 4.

Although the replies indicate a difference in observation between some advisers on the frequency of use by teachers of the topic 'plastic' and the units 'discovering electricty' and 'cells and circuits' (Table 2), and a difference in observation on the children's level of interest in the unit 'growing plants' (Table 3), the lists nevertheless provide some guide to the popularity and difficulty of the topics. If a number of topics from each of the categories is investigated in the manner outlined in this paper then we should be in a position to comment on whether or not they can be handled effectively using the procedure outlined. Ways in which teachers who are interested in carrying out some research in primary science might choose a topic are listed in the Appendix.

TABLE 2: Topics listed by science advisers on the basis of teacher use.

| Well Used | Seldom Used |
|---|---|
| metals (Level 3) | metals (Level 1) |
| discovering electricity | discovering electricity |
| cells and circuits | cells and circuits |
| plastics | plastics |
| fibres | wood |
| solar system | sun |
| drying | light and heavy |
| sound, and hearing sound | heat energy |
| magnets | levers |
| shadows | weather stations |
| mammals | tropical fish |
| bones | introduced wild animals |
| fossils | photography |
| skeleton | |
| spiders | |
| native bush | |
| roadside | |
| seeds | |

TABLE 3: Topics listed by science advisers on the basis of children's interest.

| Interesting to children | Not interesting to children |
|---|---|
| growing plants | growing plants |
| collecting/sorting rock | wood |
| shadows | small plants |
| bones | aluminium |
| chick rearing | |
| cells and circuits | |
| measuring wind | |
| seeds | |
| mould | |
| plastics | |
| magnets | |
| skeletons | |
| mammals | |
| spiders | |
| sound | |
| fossils | |
| fibres | |
| birds | |
| sense of touch | |

TABLE 4: Topics listed by science advisers as containing ideas that may be too difficult for primary children.

| Topics or Units | |
|---|---|
| discovering electricity | wood |
| cells and circuits | slaters |
| pulleys | air around us |
| starting/stopping | fire |
| action/reaction | rain |
| motion downwards | plastics |
| lenses and light | pollution |
| magnifying glass | conservation |
| flight | solar system |
| relative position | time |
| heat energy | common gases |
| earth's changing surface | |

## FINALLY

The suggestion in the first framework paper (Osborne, 1982) that teachers be involved in the research at an early stage has proved of great value. Insights gained from working alongside teachers (and children) have contributed to the revised framework which in turn incorporates teachers even more closely into the design of the research. In effect indepth and action-research involving researcher and teacher are seen as interdependent. In addition, teacher involvement is probably a valuable form of inservice training for those teachers who participate in the research.

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Appendix

# EXPERIMENTING WITH AN ALTERNATIVE APPROACH TO THE TEACHING AND LEARNING OF PRIMARY SCIENCE: Notes for teacher-researchers.

Fred Biddulph

February 1983

Learning in Science Project (Primary) University of Waikato

THE LEARNING IN SCIENCE PROJECT (PRIMARY)

Like the Form 1 to 4 Learning in Science Project (1979-81), the Primary Project is located at the University of Waikato under contract to the New Zealand Department of Education and is directed by Dr Roger Osborne and Professor Peter Freyberg. The contract period is 1982-84. The establishment of the Primary Project really stemmed from some of the findings of the Form 1 to 4 Project, for example, that primary-trained teachers at the Form 1 and 2 level were experiencing various difficulties teaching science, and children were entering Form 1 with ideas (of say, 'animal') that were inconsistent with the views of scientists. Indeed there was evidence to suggest that some of the children's ideas at age 5 years were closer to those of scientists than at age 11 years. Hence the decision was made to set up the Primary Project, not to evaluate the curriculum, teachers or children, but to identify difficulties that teachers were having teaching primary science, to investigate the difficulties that primary children were having learning science, and to explore ways in which the difficulties might be overcome.

During 1982 interviews with almost one hundred inspectors, teachers college science staff, science advisers, principals, teachers and children, together with observations of a range of science lessons, indicated that both teachers and children were experiencing a number of difficulties. Many teachers, it appeared, felt that they had an inadequate background in science and as a consequence they lacked confidence in teaching it. The storage, organisation and use of equipment caused further difficulties. Another difficulty concerned what primary science should really be trying to do. Even science educators held diverse views on this, although most teachers seemed to interpret their role as one of giving children certain science knowledge.

For their part, children had difficulty understanding various words and ideas used by teachers, and they had difficulty following some instructions. Not surprisingly, perhaps, they tended to interpret phenomena on the basis of their prior understandings built up from everyday experiences of the world around them, but the teacher normally remained unaware of these interpretations. Also, not surprisingly, the children would sometimes pursue purposes, follow procedures and come to conclusions other than those intended by the teacher. Some of these points are illustrated by a non-science example in which 5 to 7 year old children used their understanding of death and graves to reach a conclusion not intended by their teacher: the day before Anzac day the teacher took the children to a local war memorial (which was in the form of an obelisk with the names of local soldiers who had died in the two world wars engraved on it) and told the children about Anzac and the significance of the memorial. She was later amazed to learn that the children thought the soldiers were buried under the monument.

Identifying difficulties is one matter; finding ways to overcome them is another. To enable some progress to be made in this direction it was necessary for the Project to adopt some perspective as to what primary science is. Extensive considerations culminated in the view that science should enable primary children to do things and to think about things so that they make better sense of <u>their</u> world and begin to appreciate that other explanations are possible and, in some cases, may be more useful than their own.

It was also necessary to work out some procedures that would enable teachers to gain greater confidence in themselves as science teachers at the same time as they helped children make better sense of their world. After trying a number of things with children in classrooms and after considerable discussion it seemed that an alternative teaching approach might offer a procedure that would,

(a) allow researchers to gather information about children and their learning of various topics that would be of value to teachers in their planning, and
(b) provide teachers with a way of teaching that would possibly overcome the difficulties mentioned.

## THE ALTERNATIVE TEACHING APPROACH

Steps in the proposed alternative approach to teaching science are outlined below.

Step 1: CHILDREN IN INTERESTING SITUATION

A situation that stimulates the children to ask questions related to a science topic.

Step 2: CHILDREN'S QUESTIONS ON THE TOPIC

These could be publicly recorded eg. on the board.

Step 3: CHILDREN'S SUGGESTED ANSWERS TO A QUESTION

These could be written on paper by the children either individually or in groups and, if desired, listed on the board as well.

Step 4: CHILDREN'S RESEARCH PROPOSALS

At this step the children either individually or in groups write a research proposal outlining:
(a) the question/answer they are going to check on
(b) how they are going to check on it
(c) where they are going to check on it
(d) how long they estimate they will take
(e) what equipment they will need

Teacher approval will be necessary before children embark on Step 5. A teacher may decide to accept some proposals that are doomed to failure but from which children will learn something useful.

Step 5: CHILDREN'S RESEARCH ACTIVITY

The children conduct an inquiry on <u>their</u> problem using <u>their</u> suggested activity. This may be
(a) observation or 'experiment'
(b) consulting books
(c) consulting knowledgeable people

Step 6: CHILDREN'S RESEARCH REPORT AND PEER COMMENTS

The children report their findings to the rest of the class. The other children, with teacher guidance, comment on
(a) whether or not the group or individual had really found out what they were trying to find out
(b) possible alternative explanations
(c) other studies that might follow

The emphasis in the proposed alternative teaching approach is on the children engaging in inquiry in a manner appropriate to young scientists, including the consultation of books and people. Provided the teacher is an interested learner - "a leading learner amongst learners" - then having little prior science knowledge or little experience in science inquiry should prove no handicap. If a teacher finds children's questions interesting and something that teacher and children collectively will attempt to seek answers to, then children's questions are not likely to pose a threat. Further, questions and explanations from various cultural perspectives may be given serious consideration. With respect to equipment, since the children will be exploring things which are within their experience, it is likely that readily available equipment will be required most of the time, and indeed on some occasion little or no equipment may be needed.

To assist teachers interpret the alternative teaching approach some additional notes follow. It is recognised, however, that teachers may wish to vary the approach to suit their particular circumstances.

1. Children in interesting situation

This means putting the children in a situation that stimulates them to ask questions on a particular topic. The situation could involve, for example,

- the children exploring apparatus/equipment that has been assembled
- the children viewing a film, slides, listening to a tape or person
- discussion of a related item from the newspaper, radio or television
- a field trip or other out-of-school experience
- the children observing and perhaps drawing

The children should know that they will be asked for their questions at the end of the stimulus period.

2. Children's questions

In relation to a particular topic this means having the children ask questions of aspects that they want to know more about, for example, things that interest them or puzzle them. After the questions have been recorded on the board the teacher has several options as to how to continue, eg.

(a) the teacher could choose one of the questions for further study, or
(b) individual children, or groups of children, could select one (or more) of the questions that particularly interested them, or
(c) the teacher could survey the children to establish which question(s) was the most popular and use that (or those) as the basis for further work.

3. The suggested answers

This means having the children write what they think the answer(s) might be to the question(s) chosen above. Children can usually think of more than one likely answer. For this and subsequent work it is probably desirable to allow children to work in pairs or groups of three if they wish. Some prefer to work individually though. Some also prefer not to read out what they think the answer(s) might be to a particular question because they may not be very firmly committed to their answer. In such cases the teacher could simply collect the children's papers.

4. Children's research proposals

In considering which question(s) and answer(s) the children will investigate, the teacher may need to focus children's interests towards those answers which the children can evaluate by means of their own experimental investigations, their own thought experiments (that is, use of their powers of logical thinking) or by reference to the experimental findings of others which the children can obtain either through personal contact or through reading books. The teacher will also need to accept or reject (since it may involve hurt, danger, damage) the children's research proposals, or help them to modify them in some way.

5. Children's research activity

During this step the children may turn to the teacher as a resource person, or otherwise seek the teacher's assistance with their inquiries.

6. Children's reports and peer comments

This means the children reporting back to the class in written and/or visual form. The children will speak to their reports, and at the conclusion the other children, with teacher guidance, will comment on the report that they have just heard.

## THE RESEARCH IN PROGRESS

Current research is exploring the measure of support that teachers need to use the alternative teaching approach or variations of it. It is thought that teachers could find it helpful to have information about the kinds of situations that stimulate children to ask questions on specific topics, about the questions that children at various levels tend to ask and the explanations they tend to suggest on those topics, about the ideas that children have for words associated with those topics, and about the investigatory and communication skills that children tend to use and/or are capable of using in pursuit of those topics. The Project, however, has relatively limited resources to gather such information and will therefore have to concentrate on a few topics at Level 2 and Level 3.

## HOW TEACHERS AND OTHERS CAN ASSIST

1. The type of data required

Teachers, principals and advisers with an interest in improving teaching and learning could assist the Project, and hence teachers generally, by gathering some of the information mentioned above. (It is even possible that some teachers may be able to shape part of their personal diploma or degree studies in this direction.) In particular, it would be valuable to receive from teachers the following information, gained through the use of the alternative teaching approach:

(a) the class level and science topic used (eg. S.3, slaters)

(b) a description of the situation that the teacher used or devised to stimulate the children's questions

(c) a list of the children's questions on the topic (in their own words)

(d) an indication of which questions the children considered most interesting

(e) a list of,

(i) the children's suggested explanations to one (or more) of the questions (again, in their own words),

(ii) the investigations that they proposed,

(iii) problems that they had carrying out the investigations,

(iv) difficulties that they might have experienced in reporting on, or commenting on their findings,

(f) how the children responded to the alternative teaching approach

(g) any other comments that the teacher feels would assist other teachers in taking the topic.

## 2. Choosing a topic for investigation

There are several possible sources from which a topic may be chosen and teachers who wish to carry out some research may decide for themselves which source and which topic suit them.

(a) A topic may be taken from a Departmental resource unit eg. 'wood'. If this is done, it is not intended that the steps of the unit be followed but rather that the topic of the unit be investigated in the manner outlined in these notes.

(b) A topic may be chosen from the Primary Science Syllabus Appendix A (New Zealand Department of Education, 1978) itself eg. 'force'.

(c) A topic that provides an observable centre-of-interest may be chosen eg. 'aquarium'.

(d) A topic that forms a thematic study may be chosen eg. 'conservation' or 'pollution'.

(e) A topic may be obtained from a list of concepts considered basic to primary science. Such a list has been constructed by Harlen (1982) who has done extensive research in primary science. That part of the list from which topics could be drawn is reproduced below.

| | |
|---|---|
| * living things: | animals (including ourselves), plant, growth, food, senses, life cycle, health; and later extended to basic life processes, interdependence, adaptation. |
| * materials: | variety/characteristics of the main groups occurring in the environment. |
| * air: | at first concerned with its existence, use by living things; later extended to water vapour, pollution. |

| | |
|---|---|
| * water: | at first its occurrence, use by living things, sinking/floating, dissolving/not dissolving; later extended to freezing, melting, evaporation, pollution. |
| * soil: | composition, function, fertility. |
| * earth & sky: | existence of sun, moon, stars and planets. |
| * movement: | at first causes of movement, speed; later, uniform and changing speed. |
| * force: | types, effects on movement. |
| * electric current: | |
| * change: | in materials, sky, weather, living things. |
| * cause and effect: | |

A final comment that could be made in relation to topic choice is that the Project team would value data on both seemingly difficult topics for children and appealing topics for children. Some indication of which topics may be difficult for children was provided by a group of science advisers in November, 1982. They listed the following topics as containing ideas that were perhaps too difficult for children at the levels suggested.

Topics or units

| | |
|---|---|
| discovering electricity | wood |
| cells and circuits | slaters |
| pulleys | air around us |
| starting/stopping | fire |
| action/reaction | rain |
| motion downwards | plastics |
| lenses and light | pollution |
| magnifying glass | conservation |
| flight | solar system |
| relative position | time |
| heat energy | common gases |
| earth's changing surface | |

## 3. Working as a researcher with children

Special mention should be made of the difficulty that many teachers initially experience in working in a research role. They usually find themselves wanting to teach the children rather than trying to find out what the children really think. In this particular research the teacher should endeavour to avoid teaching the children (eg. by

cross-examining them to lead them to an answer) during the 'interesting situation' phase, should try to avoid answering the questions that the children ask, and should avoid making value judgements about the explanations or answers that the children suggest. Two examples are provided to illustrate what is meant. The first shows the kind of communication by the teacher that should be avoided if the real thinking of children is to be investigated.

Teacher: Now, do you have any questions about plastic?

Child: Why can't plastic burn?

Teacher: That's a silly kind of question, Mark. I thought you would have known that plastic burns.

The second example shows an approach that accepts the child's statement and sympathetically probes to clarify the basis of the child's thinking.

Teacher: What do you think the answer might be to this question: will seeds ever grow on the moon?

Child: I think it would be impossible, unless you were a very good scientist about the moon.

Teacher: Are you saying that a scientist could grow a seed on the moon but you couldn't?

Child: Yeah, they've (scientists) got all the gear and they'd probably have lots of chemicals and all that.

Teacher: I see.

FURTHER INQUIRIES AND COMMUNICATION OF RESULTS

If any teacher requires clarification of any point mentioned in these notes then please do not hesitate to contact the Project research officer below, to whom results of any pieces of research undertaken should also be communicated. Best wishes.

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